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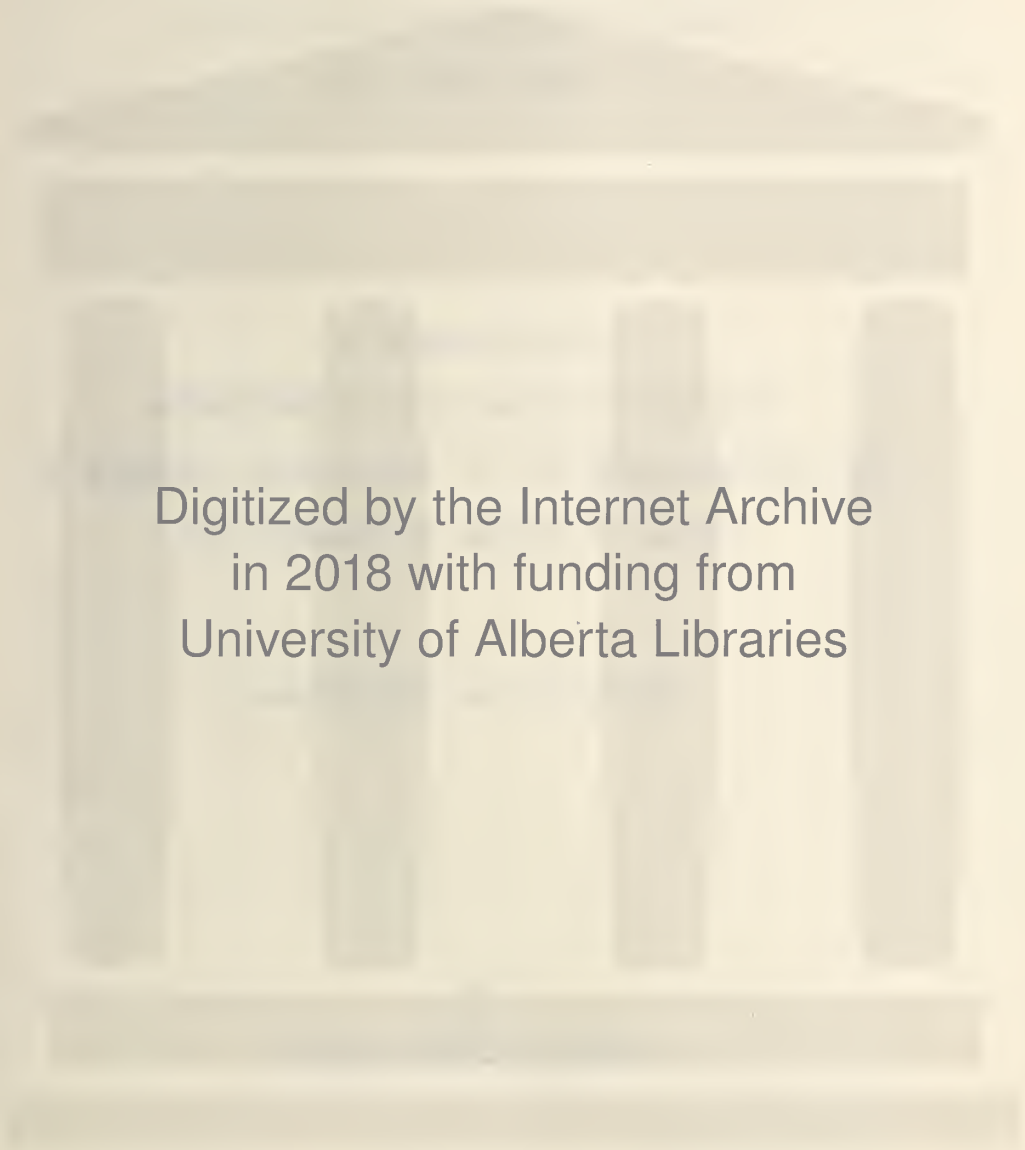

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THE UNIVERSITY OF ALBERTA

A REPORT ON THE ALGEBRA 3 PAPER OF JUNE 1938

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR

THE DEGREE OF MASTER OF ARTS

DEPARTMENT OF EDUCATION

BY

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EDMONTON, ALBERTA

MAY, 1941

1941
#39

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CHAPTER 1

PURPOSE OF THE INVESTIGATION

In June, 1938, two thousand six hundred high school students sat for an examination in Algebra 3, one of the Senior Matriculation courses giving entrance to the Provincial Normal Schools and to the University of Alberta. The results of that examination, in the opinion of the marking group, showed "a lamentable and widespread ignorance of the most elementary ideas and manipulations involved in the course." One is led to concur in this opinion when the following facts are contemplated: seventy-seven per cent of the candidates obtained less than fifty marks; the median mark was thirty-three; the first tercile was twenty-six, and the second tercile, forty-two.

The purpose of this investigation and report is to find, if possible, the cause of such a poor showing. A sample of the papers was investigated to determine the specific weaknesses of the students in this subject. The Question Paper will be criticized, as a test of this course, in the light of its content and nature. Finally, other factors which in the author's judgment have a bearing on the poor results will be discussed.

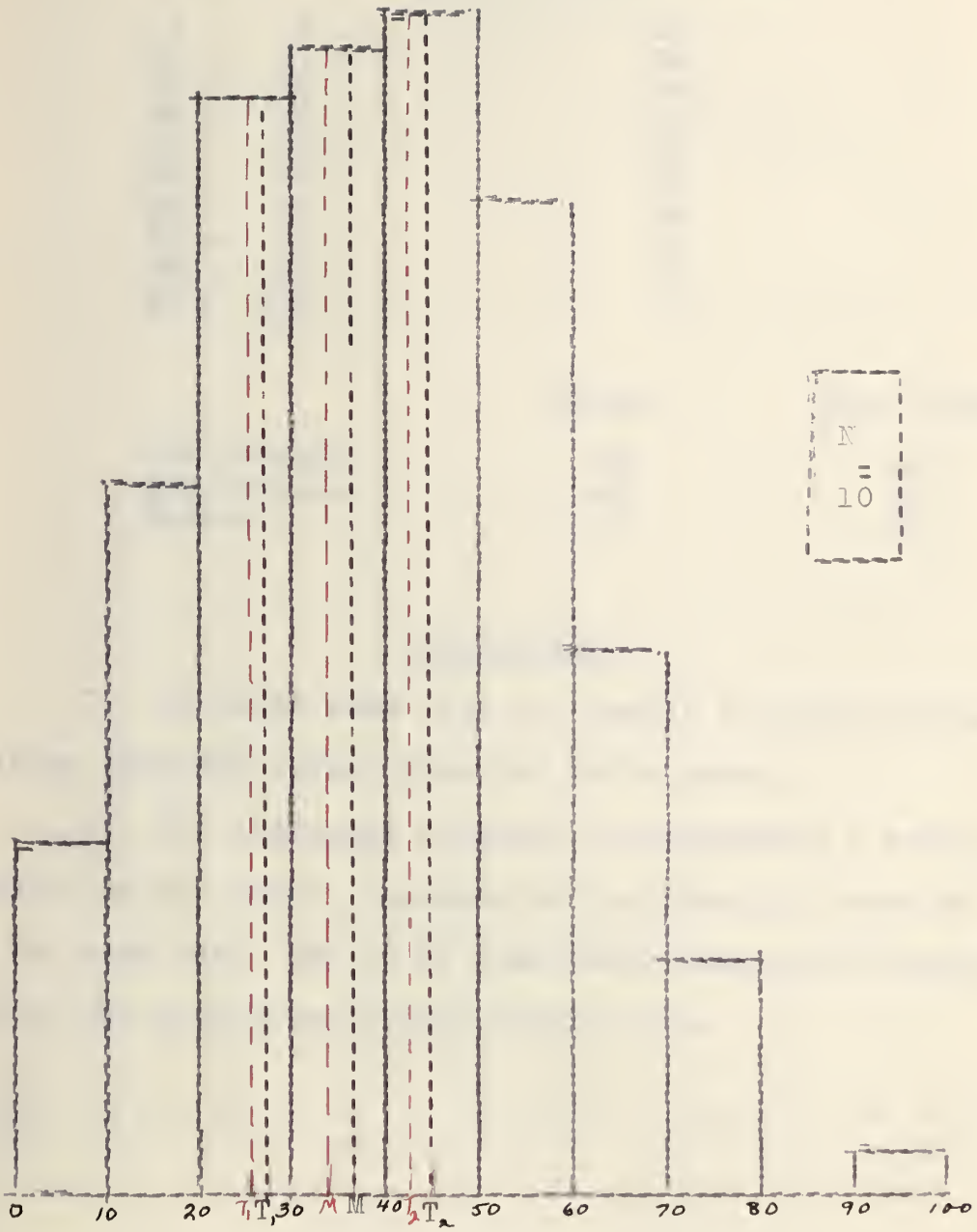

Figure 1.

Histogram, showing mark distribution of the sample of 329 papers with median and tercile marks.

DATA FROM HISTOGRAM

Range	Frequency "N"
0 - 9	19
10 - 19	38
20 - 29	59
30 - 39	61
40 - 49	62
50 - 59	52
60 - 69	26
70 - 79	11
80 - 89	0
90 - 100	1

	Sample	Total Group[1]
1st tercile	28	26
2nd tercile	45	42
Median	37	33

Conclusions

1. It would seem that the sample is fairly reliable, grading slightly higher than the whole group.

2. The histogram indicates unmistakably a very poor showing on the paper, inasmuch as technically a mark of 50 is the pass mark, and it is considered that approximately 75% of the candidates should attain this.

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1. The red notations on the histogram pertain to the score of the whole group, and indicate the reliability of the sample.

HIGH SCHOOL AND UNIVERSITY
MATRICULATION EXAMINATIONS BOARD

DEPARTMENTAL EXAMINATIONS, 1938

ALGEBRA 3

Time—$2\frac{1}{2}$ hours.

Note—Candidates will attempt *all of Section A* and *three questions* of *Section B*.

SECTION A

Values

2 **1.** (*a*) Show that $4\sqrt{3} + 8$, $2 + 2\sqrt{3}$, and 2 are in continued proportion.

3 (*b*) Find the next term of the continued proportion in (*a*).

5 (*c*) A city receives its water supply through a water-main from a reservoir. By what per cent would the diameter of the main have to be increased to double the supply?

2 **2.** (*a*) Prove that if $y = f(x) = \dfrac{ax + b}{cx - a}$, then $x = f(y)$.

2 (*b*) Sketch the graph of $y = \dfrac{x + 2}{x - 1}$.

2 (*c*) Discuss the statement that $\dfrac{x^2 - 1}{x - 1}$ is always equal to $x + 1$.

2 (*d*) If possible, find a value of x for which $\dfrac{x^2 - 1}{x - 1} = 2$.

1 (*e*) Find $\underset{x \to 1}{Lt} \dfrac{x^2 - 1}{x - 1}$.

1 (*f*) Draw the graph of $y = \dfrac{x^2 - 1}{x - 1}$.

5 **3.** (*a*) Given $y = x^3$, find $\triangle y$ when $x = 1$ and $\triangle x = -0.2$.

5 (*b*) Find $\dfrac{d}{dx}\left(3x^4 - \dfrac{1}{2x} + 7\sqrt{x} - \dfrac{6}{\sqrt{x}}\right)$.

10 **4.** A rectangular tank with open top and square base is to hold 500 cu. ft. Express as a function of the side of the base the cost of lining the tank with lead at 20ϕ per square foot. Find the dimensions for which the cost is a minimum, using in the proof the second derivative of the cost.

5 **5.** (*a*) The 8th term of a G.P. is xy^{16} and the 13th is $\frac{y^{26}}{x^4}$. Find the 2nd term.

5 (*b*) The cost of drilling a well is as follows:

first 10 feet, 27ϕ per foot,
second 10 feet, $28\frac{1}{2}\phi$ per foot,
and continues to increase by $1\frac{1}{2}\phi$ per foot at every ten feet of depth. Find the cost of drilling a 920-foot well.

7 **6.** Find the cash value of an annuity of \$800, deferred five years and running for 20 payments, interest at 5% per annum.

3 **7.** Find the coefficient of x^4 in $(1 - 2x)^2 (1 + x)^6$.

5 **8.** Solve: $\frac{dy}{dx} = 2x - x\sqrt{x} + \frac{3}{\sqrt{x}}$.

5 **9.** Find n if ${}^nP_5 = 120\,{}^nC_3$.

SECTION B

Attempt three questions only.

10. Given $y = \sqrt{z}$, and $z = 1 - x^2$,

3 (*a*) Prove $\triangle y$ is approximately equal to $\frac{1}{2\sqrt{z}} \triangle z$.

2 (*b*) Express $\triangle z$ in terms of x and $\triangle x$.

2 (*c*) Express $\triangle y$ in terms of x and $\triangle x$.

3 (*d*) Find $\frac{d}{dx} \sqrt{1 - x^2}$.

10 **11.** Use integration to find the volume of the solid generated by the rotation, about the axis of x, of the area enclosed by the axis of x, the lines $x = -2$ and $x = 2$, and the portion of the curve $y = 6 - x^2$ which lies between these two straight lines.

Values

10 **12.** Auto license plates are issued showing five digits, the first digit not being zero. How many additional plates could be made if in the third place one of the 26 letters is used instead of a digit?

10 **13.** Given the table of values

x	6	8	10	12	14
y	29	36	45	56	69

use a graph to find a relation of the form $\log y = a + bx$ which will best fit these data.

From this relation compute y when $x = 11$.

10 **14.** Find if possible (a) minimum values and (b) maximum values, of $\frac{x^2 - 3x + 4}{x}$, using in your explanation of each a rough graph of the function.

100

Chapter 11

AN INVESTIGATION OF SOLUTIONS TO QUESTIONS AS OFFERED BY CANDIDATES

The following is a report of an investigation of 329 papers, being a sample consisting of every eighth paper in the group, as supplied by officials of the Department of Education.

The score of each question is given as a percentage of the total group:- the percentage giving a correct solution, the percentage making error, and the percentage not attempting the question.

Prominent errors in each question have been recorded and, unless otherwise stated, their prevalence has been estimated as a percentage of the group attempting the question.

It was assumed that the candidate would submit, or would attempt to submit a type solution to the questions on the paper.

QUESTION 1 a

1. Solution:	N	%
Correct	185	56
Errors	93	28
Not attempted	51	16

2. Factors Involved

a. Meaning of term "continued proportion."

b. Realization of problem, ie. failure to see what was involved in showing that proportion was correct.

c. Manipulation of fractions and surds.

3. Errors (Percentages are of 278 papers)

	N	%
a. Meaning of term	52	19
b. Realization of problem	31	11
c. Mechanical--fraction & surds	10	4

QUESTION 1 b

1. Solution	N	%
a. Correct Solution	169	51
b. Error	85	26
c. Not Attempted	75	23

2. Factors involved in solution.

   a. Set-up for next term.

   b. Solution of equation.

   c. Manipulation of surds.

3. Errors (Percentages are of 254 papers)

	N	%
a. Incorrect set-up.	37	15
b. Surds (chiefly in rationalization necessary to bring result to its simplest form)	19	8
c. Laws of equations.	8	3
d. Simplification by decimals.	5	2
e. Mechanical errors.	16	6

4. Criticism of 1 (a) & 1 (b)

The term "continued proportion" is defined in one line in the text and no questions using the term appear at all. This might explain the low score on a question seemingly simple.

QUESTION 1 (c)

1. Solution	N	%
a. Correct Solution.	48	14
b. Errors.	216	66
c. Not Attempted.	65	20

2. Factors involved in solution:

   a. Statement of variation relation $S \propto d^2$ or $d \propto \sqrt{S}$

   b. A statement of a proportion $\frac{S_1}{S_2} = \frac{d_1^2}{d_2^2}$ or $\frac{d_1}{d_2} = \frac{\sqrt{S_1}}{\sqrt{S_2}}$, and substitution.

   c. Evaluation of $\frac{d_1}{d_2}$

   d. Evaluation of increase and percentage increase.

3. Errors: (Percentages are of 264 papers)

	N	%
a. Incorrect variation relation.[i]	99	36
b. Proportion and substitution.	52	19
c. Evaluation of increase and percentage increase.	36	13
d. Particular case.	9	3
e. Equation laws.	3	1
f. Indices.	4	1
g. Mechanical errors (Fractions & Arithmetic)	26	10

4. Comment: Undoubtedly these results indicate a very haphazard knowledge of the principles of variation and proportion.

---

[i] chief errors were: $s \propto d$ & $s \propto d^3$

QUESTION 2 (a)

1. Solution:	N	%
a. Correct Solution.	96	29
b. Error.	84	26
c. Not Attempted.	149	45

2. Factors Involved:

a. "x" must be expressed as a function of "y" .

Equation laws.

b. Evaluation of f(y).

3. Errors: (Percentages are of 180 papers

a. "x" expressed as a function of "y".

	N	%
1. Not attempted.	10	6
2. Not completed.	52	29
3. Equation laws.	5	3
b. In evaluation of f(y)	62	34

QUESTION 2 (b)

1. Solution:	N	%
a. Correct Solution.	213	65
b. Error.	101	31
c. Not Attempted.	15	4

2. Factors Involved.

a. A complete range of variation of "x" .

b. Trends of the functions

$x \to -\infty$
$x \to 1 \quad x<1$
$x \to 1 \quad x>1$
$x \to \infty$

3. Errors: (Percentages are of 314 papers)

	N	%
a. Incomplete range.	43	14
b. Trends.		
$x \to -\infty$	27	9
$x \to 1 \quad x<1$	26	8
$x \to 1 \quad x>1$	14	5
$x \to -\infty$	20	6

QUESTION 2 (c)

1. Solution:	N	%
a. Correct Solution.	77	23
b. Error.	235	72
c. Not Attempted.	17	5

2. Factors Involved.

   a. The expression is meaningless when "x"= 1

3. Possible causes of error.

   a. Failure to understand problem and extent of answer required.

   b. Ignorance of fact that division by "o" gives a meaningless expression.

   c. Recognition of a value of "x" to make denominator zero.

4. Errors. (Percentage is of 312 papers)

	N	%
It was impossible to distinguish between the causes of error.	235	75

QUESTION 2 (d)

1. Solution:

	N	%
a. Correct Solution.	175	53
b. Error.	130	40
c. Not Attempted.	24	7

2. Percentage is of 305 papers

	N	%
Errors.	130	43

The error was invariably a failure to recognize a zero denominator, and the result of such an expression. The results were better in this question than in 2 (c) however, and leads one to wonder why, when 53% apparantly saw the

QUESTION 2 (d) cont'd

"trick" in 2 (d), only 23% of the students made use of their knowledge in 2 (C).

QUESTION 2 (e)

1. Solution:	N	%
a. Correct Solution.	175	53
b. Error.	132	40
c. Not Attempted.	22	7

2. Errors. (Percentages are of 307 papers)

			N	%
a. Introduction of Δx in denominator to give rate of change of function.			23	8
b. Guesses.	Lt = 1	22		
	= 0	71		
	= ∞	16	109	36

QUESTION 2 (f)

1. Solution:	N	%
a. Correct Solution.	112	34
b. Errors.	162	49
c. Not Attempted.	55	17

2. Errors. (Percentages are of 274 papers)

	N	%
a. Restricted range or incorrect trend	99	36
b. Trend as $x \to 1$, $y \to \pm \infty$	63	23

Comment and Criticism. Question 2

a. Parts "b" & "f" demonstrate a serious weakness in the graphical representation of functions.

b. The concepts, "division by zero", and "limiting value of an expression" are not well understood. However the poor results of 2 (c) are a result of misinterpreting the question, as shown by the better results in 2 (d) & 2 (e).

QUESTION 3 (a)

1. Solution:	N	%
a. Correct Solution.	147	45
b. Errors.	154	47
c. Not Attempted.	28	8

2. Factors Involved.

a. Meaning of Δy

b. Value of Δy in terms of Δx

c. Evaluation.

d. Possibly the use of approximation formula $\Delta y \simeq \frac{dy}{dx} \cdot \Delta x$ with substitution and evaluation.

3. Errors. (Percentages are of 301 papers)

	N	%
a. Incorrect expression of Δy in terms of Δx	57	19
b. Division of Δy by Δx, a confusion with rate of change of function at a point.	25	8

QUESTION 3 (a) cont'd

c. Substitution.	12	4
d. Mechanical (Sign, Addition)	44	15
e. Formula (Substitution)	9	3
f. Unclassified.	3	1

4. Comment.

The important difficulty is the meaning of the symbols $\triangle y$ & $\triangle x$. A misunderstanding of these symbols accounted for errors "a" & "b", ie. 27% of those attempting the question, (25% of the total) in addition to 9% of the total who did not attempt the question.

QUESTION 3 (b)

1. Solution	N	%
a. Correct Solution	113	34
b. Error.	206	63
c. Not Attempted.	10	3

2. Factors Involved.

a. Rule for finding derivative.

b. Index laws.
   1. Negative index.
   2. Fractional index.
   3. Negative fractional index.

QUESTION 3 (b) cont'd

3. Errors. (Percentages are of 319 papers)

	N	%
a. First term. (This would constitute a lack of knowledge of the differential rule, as almost invariably, no success was scored in the following terms.)	21	7
b. Negative index (2nd term exclusive of errors in rule and mechanics.	156	49
c. Fractional index (3rd term ditto)	32	10
d. Negative fractional index (4th term ditto)	58	18
e. Mechanical Error.	5	2

4. Comment.

The errors made show, not so much an inability to differentiate, nor a lack of understanding of the process, as a lack of facility in handling indices.

QUESTION 4

1. Solution:	N	%
a. Correct Solution.	45	14
b. Error.	215	65
c. Not Attempted.	69	21
N.B. Correct solution neglecting 2nd differential test.	106	32

2. Factors Involved.

   a. Expressing area as a function of a side "x".

   b. Expressing cost, "y", as a function of "x".

   c. Differentiating....ie. $\frac{dy}{dx}$

   d. Finding "Turning Points".

   e. Test...$\frac{d^2y}{dx^2}$ .... with interpretation.

3. Errors in steps a-d are cumulative, that is, an error in expressing area as a function of the side is continued as an error in the cost. The test of the turning point is treated in the more general method. The derived function arrived at by the student was considered correct for this purpose.

QUESTION 4 cont'd

4. Scores of steps. (Percentages are of 260 papers)

	N	%
a. Area a function of the side.		
1. Correct solutions.	170	65
2. Incorrect.	90	35
b. Cost a function of side.		
1. Correct solution.	157	60
2. Error.	64	24
3. Not attempted.	39	15
c. Derived function.		
1. Correct Solution.	110	42
2. Error.	45	17
3. Not attempted.	105	40
d. Turning points.		
1. Correct solution.	106	41
2. Error.	14	5
3. Not attempted.	140	54
e. Test--Second Differential.		
1. Correct solution.	63	24
2. Error.	14	5
3. Not attempted.	183	70
f. Interpretation of test (e)		
1. Correct interpretation.	55	21
2. Error.	3	1
3. Not attempted.	202	78

QUESTION 4 cont'd

5. Comment and Criticism.

It is the writer's opinion that the second differential is not stressed by the teachers as a test of the turning point. In fact it is not definitely indicated as such in the text.

The results from the question are a little more encouraging when we realize that, neglecting the second differential test, thirty-two percent of the students obtained the correct solution.

QUESTION V (a)

1. Solution:	N	%
1. Correct solution	53	16
2. Error.	168	51
3. Not attempted.	108	33

2. Factors involved.
   1. Formula--nth term of a "GP"---ar^{n-1}
   2. Division to obtain "r^5".
   3. Fifth root to obtain "r".
   4. Evaluating "a".
   5. Evaluating "ar"

QUESTION V (a) cont'd

3. Errors. (Percentages are of 221 papers)

	N	%
a. Errors in formula.	39	18
b. Errors in index laws (This includes finding "r^5" & "r")	85	37
c. Considering "r" as 2nd term and neglecting to find "a" & "ar"	15	7
d. Mechanical errors.	5	2
e. Confusion with "AP".	26	11
f. Unclassified errors.	6	2

4. Comment.

The concept "Geometric Progression" has not been well grasped. The high percentage not attempting the question, and errors a, c, & e, show this unmistakably. Again however, indices give a great deal of trouble.

QUESTION V (b)

1. Solution:	N	%
a. Correct Solution.	44	13
b. Errors.	246	75
c. Not Attempted.	39	12

2. Factors involved.

a. Recognition of series as A.P.

QUESTION V (b) cont'd

b. Set up of series.

1. Recognition of "10" as a common factor of terms in the series.
2. Number of terms.
3. Common difference.

c. Summation formula.

d. Evaluation.

3. Errors. (Percentages are of 290 papers)

	N	%
a. Series classed as "G.P."	16	6
b.1. Failure to recognize "10".	91	31
2. Errors in series--number of terms and common difference.	70	24
c. Errors in summation formula.	40	14
Summation not attempted.	5	2
d. Sum given as nth term.	22	8
e. Mechanical errors.	62	21
f. Unclassified errors.	5	2

QUESTION VI

1. Solution:	N	%
a. Correct Solution	24	7
b. Error.	247	75
c. Not Attempted.	58	18

QUESTION V1 cont'd

2. Factors involved.

   a. Statement of the annuity.

   b. Deferring of the annuity.

   c. Summation of the annuity.

   d. Evaluation--use of logs.

3. Errors.

   a. Statement of annuity. (Percentages are of 271 papers)

	N	%
1. Correct.	129	48
2. Error.	78	29
3. Not attempted.	64	24

   b. Summation formula.

   Correct annuity.....129

   Annuity not attempted... 64

   193 papers.

	N	(% of 271)	(% of 193)[1]
1. Correct summation	132	48	69
2. Error in formula.	61	23	31

[1] (Note: The latter percentages are more valid as, when an error was made in the annuity, no record was kept as to whether such series was summed correctly or not.)

QUESTION V1 cont'd

c. Evaluation of Summation Expression.

(132 papers with correct summation expression)

	N	(% of 271)	(% of 132)
a. Correct.	24	9	18
b. Mechanical. (Logarithms)	98	36	74
c. Not completed	10	4	8

4. Comment.

Errors in the Series arose from:

1. Confusion with accumulation series.
2. Incorrect first term.
3. Incorrect last term.
4. Deferring of the annuity--accounting for only 4 errors.

QUESTION V11

1. Solution	N	%
a. Correct Solution.	97	29
b. Error.	147	45
c. Not Attempted.	85	26

2. Factors involved.

   a. Expansion of Binomials $(1-2x)^2$ & $(1+x)^6$.

   b. Choice of terms relevant to problem.

   c. Multiplication of relevant terms.

   d. Addition of coefficients of products.

3. Errors. (Percentages are of 244 papers)

	N	%
a. Errors in expansion of binomials 34		
From $^{n}C_{r}$ form 9	43	19
b. Error in choice of terms...		
usually incomplete choice.	43	18
c. Multiplication of terms.	31	13
d. Addition of coefficients.	25	14
e. Coefficient of 4th term in either		
expansion given as result.	2	1
f. Unclassified.	3	2

QUESTION V111

1. Solution:	N	%
a. Correct Solution.	29	9
b. Error.	277	84
c. Not Attempted.	23	7

QUESTION V111 cont'd

2. Factors involved.

   a. Meaning of problem--

      Solution of the differential equation.

   b. The rule for integration.

   c. Index laws.

   d. The "Constant" or "Parameter".

3. Errors. (Percentages are of 306 papers)

	N	%
a. Confusion with differentiation.	22	7
b. Error in rule (as indicated by mistake in first term)	30	10
c. Error in index laws.	148	48
d. Mechanical errors.	14	5
e. Failure to append parameter.[i]	185	60

[i] Note: Failure to append parameter accounted for errors in 60 solutions which were otherwise correct. This is 19% of the total, and would increase the score for the correct solution to 27% of the total population.

QUESTION 1X

1. Solution:	N	%
a. Correct Solution.	141	43
b. Error.	138	42
c. Not Attempted.	50	15

2. Factors Involved.

a. Meaning of ${}^{n}P_{5}$

b. Meaning of ${}^{n}C_{3}$ [1]

c. Solution of equations. (Cancelling of like terms)

3. Errors. (Percentages are of 279 papers)

	N	%
a. Statement of ${}^{n}P_{5}$	53	19
b. Statement of ${}^{n}C_{3}$	80	24
c. Laws of equations. (Failure to cancel)	45	16
d. Mechanical error.	5	2
e. Unclassified.	5.	2

---

[1] Note: In evaluating $120\,{}^{n}C_{3}$, sixteen candidates of the eighty making error interpreted it as $\underline{120n}C_{3}$

QUESTION X

1. Students attempting question. N = 182 .....55%

2. Solution: (Percentages are of 182 papers)

	N	%
a. Correct solution	13	7
b. Error.	169	93

3. Factors involved.

a. Formula $\Delta y \simeq \frac{dy}{dx} \cdot \Delta x$

Evaluate $\frac{dy}{dz}$ and substitute.

b. Formula $\Delta z \simeq \frac{dx}{dz} \cdot \Delta z$

Evaluate $\frac{dx}{dz}$

c. Substitution in (a) of results of (b).

d. Formula $\Delta y \simeq \frac{dy}{dx} \cdot \Delta x$

Statement of $\frac{dy}{dx}$ or $\frac{d}{dx}\sqrt{1-x^2}$

4. Errors. (Percentages are of 182 papers)

	N	%
a. i. Approximation formula not stated or stated incorrectly.	32	18
ii. Section not attempted.	19	10
lll. Incorrect evaluation of $\frac{dy}{dz}$	3	2
b. i. Formula not stated or stated incorrectly.	37	20
ii. Section not attempted.	19	10
iii. Incorrect evaluation $\frac{dz}{dx}$	8	5

QUESTION X (cont'd)	N	%
c. i. Attempted use of formula $\Delta Y \simeq \frac{dY}{dX} \cdot \Delta X$	45	25
ii. Incorrect substitution in (a)	77	43
iii. Section not attempted.	23	13
d. i. Attempted differentiation $\frac{d}{dx}\sqrt{1-x^2} = \frac{d}{dx}(1-x^2)^{1/2}$	112	62
ii. Statement of formula, but failure to draw conclusion from (c).	12	7
iii. Error in use of formula $\frac{dy}{dx} = \frac{dy}{dz}.\frac{dz}{dx}$	3	2
iv. Not attempted.	18	10

5. Comment.

In the wording of these questions in the text, there is a definite indication that each of the steps indicated in the first three sections is but a step in the solution of a larger problem. Since many students attempted parts (c) & (d) independently of (a) & (b), the relationship between the parts was overlooked.

QUESTION X1

1. Students attempting question. N = 192 .....58%

2. Solution. (Percentages are of 192 papers)

	N	%
a. Correct Solution.	35	18
b. Error.	157	82

3. Factors involved.

   a. Definite integral "set-up" for finding volume.

   b. Substitution in "set-up".

   c. Integration.

   d. Evaluation.

4. Errors. (Percentages are of 192 papers)

	N	%
a. Incorrect "set-up" for V...	81	42
i. $V=\pi\int_a^b y\cdot dx$ (most prevalent)		
ii. Omission of π		
iii. Omission of definite limits.		
b. Substitution $y^2=(6-x^2)^2$	11	6
(main error - $y^2=(6-x^2)$)		
c. Incorrect integration	7	4
d. Interpretation of limits.	8	4
e. Mechanical errors (signs etc)	38	20
f. Failure to complete.	12	7

QUESTION XLL

1. Number attempting question. N = 175 .....53%

2. Solution. (Percentages are of 175 papers)

	N	%
a. Correct Solution.	34	19
b. Error.	141	81

3. Factors involved.

   a. Number of plates--digits only.

   b. Number of plates--letter in third place.

   c. Subtraction to find number of additional plates.

4. Errors. (Percentages are of 175 papers)

	N	%
a. Use of formula ${}^{n}P_{r}$ & ${}^{n}C_{r}$ (A variety of attempts makes classification impossible)	128	73
b. No formula used, but repetition prevented.	7	4
c. Interpretation of question--difference not found.	6	3

5. Criticism.

This is a fairly simple question. The results show not so much a lack of knowledge of permutations and combinations as a tendency to rely on memory rather than do a bit of independent thinking.

QUESTION X111

1. Number attempting question n = 168 .....51%

2. Solution. (Percentages are of 168 papers)

	N	%
a. Correct Solution.	15	9
b. Error.	153	91

3. Factors involved.

   a. Preparation of table of values for "log y".

   b. Construction of graph.

   c. Solution of log equation.

      i. From proportion.

      ii. From values of "log y" & "x", substituted in equation, $\log y = a + bx$

   d. Computation of y when x = 11

4. Errors. (Percentages are of 168 papers)

	N	%
a. No table of values of log y ("y" plotted against "x", and best fitting straight line drawn. Roughly 50% of calculations based on such were carried through correctly.)	100	60
b. Although table for "log y" was prepared, graph was drawn with "y" plotted against "x".	7	4

QUESTION X111 cont'd

	N	%
c. Solution of log equation. (Incorrect proportion or incorrect points chosen.)	22	13
d. Mechanical errors.	30	18
e. Not completed.	9	5

QUESTION X1V

1. Number attemtping question. N = 171 ...52%

2. Solution: (Percentages are of 171 papers)

	N	%
a. Correct Solution.	16	9
b. Error.	155	91

3. Factors in solution.
   a. Preparation of function for differentiation.
   b. Differentiation.
   c. Turning points.
   d. Test to determine type of turning point.
   e. Turning values.
   f. Graphs.

4. Errors. (Percentages are of 171 papers)

	N	%
a. Incorrect preparation--failure to divide each term by "x".	54	32

QUESTION XIV cont'd

	N	%
b. Error in differentiation.	12	7
c. In solution of equation to find turning point.	8	5
d. Testing for type of turning point.	24	14
e. Failure to evaluate turning values.	25	15
f. Errors in graphs.	34	20
g. Attempted solution by graph.	13	8
h. Attempted solution by algebra.	12	7

The following table gives a summary of the results.

Key:

T--Percentage of candidates obtaining full solution.

E--Percentage of candidates making error.

A--Percentage of candidates attempting question.

NA-Percentage of students not attempting question.

N--Number of papers on which question was attempted.

V--Value per question.

M--Marks attempted per question.

TABLE 1

SUMMARY OF THE RESULTS

Question	T%	E%	A%	NA%	N	V	M	
1a	56	28	84	16	278	2	556	
b	51	26	77	23	254	3	762	
c	14	66	80	20	264	5	1320	
2a	29	26	55	45	180	2	360	
b	65	31	96	4	314	2	628	
c	23	72	95	5	312	2	624	
d	53	40	93	7	305	2	610	
e	53	40	93	7	307	1	307	
f	34	49	83	17	274	1	274	
3a	45	47	92	8	301	5	1505	
b	34	63	97	3	319	5	1595	
4	14	65	79	21	260	10	2600	
5a	16	51	67	33	221	5	1105	
b	13	75	88	12	290	5	1450	
6	7	75	82	18	271	7	1897	
7	29	45	74	26	244	3	732	
8	9	84	93	7	306	5	1530	
9	43	42	85	15	279	5	1395	
10	4	51	55					
a	39	11	50		163	3	489	
b	36	14	50		163	2	326	
c	11	37	48		159	2	318	
d	8	42	50		164	3	492	
11	10	48	58		192	10	1920	
12	10	43	53		175	10	1750	
13	5	46	51		168	10	1680	
14	5	47	52		171	10	1710	27935

Average number of marks attempted per paper....85

CHAPTER 111

SUMMARY OF ERRORS.

Certain mathematical principles or topics are involved in more than one question. In the following pages information relative to these topics is summarized.

Key:

N - number of students attempting question.

E - number of students making errors.

n - number of students obtaining correct solution.

Proportion

1. Question 1 (a) was based on "continued proportion". The following information results:

   (a) Students not attempting question.....16%

   (b) Meaning of term..."continued proportion"--

   N - 278 E - 52 or 19% of 278 papers.

2. Question 1 (b)

   (a) Students not attempting question.....23%

   (b) An incorrect set-up accounted for errors--

   N - 254 E - 37 or 15% of 254 papers.

3. Question 1 (c)

This question required that a proportion based on a variation relation be stated.

N - 264 E - 52 or 19% of 264 papers.

Variation

1. Question 1 (c)

From given data, a variation--relation had to be stated.

A proportion set-up resulting from above relation had to be stated.

(a) Those not attempting question....20%

(b) Incorrect variation relation ($S \propto d$ or $S \propto d^3$)

N - 264 E - 99 or 36% of 264 papers.

(c) Incorrect proportion set-up from above.

N - 264 E - 52 or 19% of 264 papers.

Functional Representation and Notation.

1. Question 2 (a)

A knowledge of symbols "f(x)" and "f(y)" was involved.

(a) Those not attempting question.....45%

(b) Those not evaluating "f(y)".

N - 180 E - 62 or 34% of 180 papers.

(c) Expressing "x" as a function of "y".

N - 180 E - 67 or 37% of 180 papers.

2. Question 3 (a)

The question requires a knowledge of symbols.

(a) Not attempted.....8%

(b) Incorrect expression of "$\triangle y$" in terms of "$\triangle x$".

N - 301 E - 57 or 19% of 301 papers.

3. Question 4

The question demanded that the cost be expressed as a function of the side.

(a) Question not attempted.....21%

(b) Area not correctly expressed as a function of side.

N - 260 E - 90 or 35% of 260 papers.

(c) Cost not expressed as a function of side.

(i) Not attempted...39 or 15% of 260 papers.

(ii) N - 260 E - 64 or 25% of 260 papers.

Graphs

1. Question 2 (b)

(a) Those not attempting solution.....5%

(b) An incomplete range.

N - 314 E - 43 or 14% of 314 papers.

(c) Error in trends.

N - 314 E - 87 (4 errors possible per paper)

2. Question 2 (f)

(a) Those not attempting question.....17%

(b) A restricted range, or complete error.

N - 274 E - 99 or 36% of 274 papers.

(c) Trend of function as $x \to 1$

N - 274 E - 63 or 23% of 274 papers.

3. Question 14

(a) Error in graph.

N - 171 E - 34 or 20% of 171 papers.

Question 14 cont'd

(b) Attempted solution of question by graph.

N - 171 E - 13 or 8% of 171 papers.

Differentiation

1. Question 3 (b)

(a) Not attempted.....3%

(b) Error in 1st term--a definite error in the rule.

N - 319 E - 21 or 7% of 319 papers.

(c) Correct solution given by 34%, the other errors being mainly because of indices.

2. Question 4.

Results in this question show only the use of the derivitive.

(a) Use of the derivitive to find turning points.

N - 260 n - 155 or 60% of 260 papers.

(b) The second differential.

N - 260. Not attempted 183 or 70% of 260 papers

3. Question 10.

(a) Differentiation presented no difficulty.

(b) A poor showing was made on the use of the formula $\triangle y \simeq \frac{dy}{dx} \triangle x$

Groups of 28% and 30% of those attempting the question made error or failed to use the formula.

(c) Attempted differentiation of $\sqrt{1-x^2}$

N - 182 E - 112 or 62% of 182 papers.

4. Question 14.

(a) Preparation of function.

N - 171, E - 54 or 32% of 171 papers.

(b) Differentiation.

N - 171, E - 12 or 7% of 171 papers.

(c) Test for Turning Point.

N - 171, E - 24 or 14% of 171 papers.

Integration

1. Question 8.

(a) Not attempted.....23.....7%

(b) Correct solution.

N - 329, n - 29, or 9% of 329 papers.

(c) Correct solution without parameter.

N - 329, n - 83, or 27% of 329 papers.

(d) Error in rule.

N - 306, E - 30, or 10% of 306 papers.

(Only one such error counted per paper)

(e) Confusion with differentiation.

N - 306, E - 22, or 7% of 306 papers.

(f) Failure to append parameter.

N - 306, E - 185, or 60% of 306 papers.

2. Question 11.

(a) Incorrect expression for "V"

N - 192, E - 81, or 42% of 192 papers.

(b) Incorrect integration.

N - 192, E - 7, or 4% of 192 papers.

Information on the other topics of the Course can be obtained directly from the report on the relevant question.

Indices

1. Question 3 (b).

This question tests differentiation, but the following points should be noted:

(a) Error in negative index.

N - 319, E - 156, or 49% of 319 papers.

(Almost invariably the error made was in considering $\frac{1}{2X} = 2X^{-1}$

(b) Error in fractional index.

N - 319, E - 32, or 10% of 319 papers.

(c) Negative fractional index.

N - 319, E - 58, or 18% of 319 papers.

2. Question 5 (a).

Having applied "G.P." formula correctly, the students had to find "r^5" and "r" by the use of the laws of indices.

2. Question 5 (a) cont'd.

In many cases this was not done, and in a few cases, error was made in index manipulation.

N - 221, not attempted or E - 85, or 37% of 221 papers.

3. Question 7.

Error was made in the choice of terms for multiplication, or an incomplete choice was made.

N - 244, E - 43, or 18% of 244 papers.

4. Question 8.

Errors definitely attributable to index manipulation, (one error counted per paper).

N - 306, E-148, or 48% of 306 papers.

Mechanical Errors.

Mechanical errors, (fractions, surds, equation laws, etc.) were relatively few in number.

1. Question 1 (a).

(a) Fractions and surds.

N - 278, E - 10, or 4% of 278 papers.

2. Question 1 (b).

(a) Surds (chiefly in rationalization necessary to bring result to its simplest form).

(b) Laws of equations.

N - 254, E - 8, or 3% of 254 papers.

(c) Other mechanical errors.

N - 254, E - 16, or 6% of 254 papers.

3. Question 1 (c).

(a) Evaluation of percentage increase.

N - 264, E - 36, or 13% of 264 papers.

(b) Equation laws. .....1% of 264 papers.

(c) Other mechanical errors.

(Fractions and arithmetic)

N - 264, E - 26, or 10% of 264 papers.

4. Question 2 (a).

"x" to be expressed as a function of "y".

N - 180, E - 5, or 3% of 180 papers.

5. Question 3 (a).

(a) In evaluation of Δy

Mechanical (signs, additions, etc.).

N - 301, E - 47, or 16% of 301 papers.

6. Question 5 (b).

(a) Mechanical errors in summation.

N - 290, E - 62, or 21% of 290 papers.

7. Question 7.

(a) Error in multiplication of terms.

N - 244, E - 31, or 13% of 244 papers.

(b) Error in addition of coefficients.

N - 244, E - 28, or 12% of 244 papers.

8. Question 8.

(a) Mechanical error in integration.

(Other than rule, index law etc.).

N - 306, E - 14, or 5% of 306 papers.

9. Question 9.

(a) Laws of equations--a failure to cancel factors.

N - 279, E - 45, or 16% of 279 papers.

10. Question 11.

(a) Mechanical error in the evaluation of the definite integral (due to signs, etc.).

N - 192, E - 38, or 20% of 192 papers.

11. Question 13.

(a) Mechanical error in simplification of log equation.

N - 168, E - 30, or 18% of 168 papers.

Logarithms--Question 6.

(a) One hundred and thirty-two candidates summed correctly the annuity given in Question 6. Seventy-four per cent of these, (thirty-six per cent of all attempting question) made error in evaluation. It was difficult to localize the errors, but it is felt that most would be due to incorrect manipulation of logarithms.

N - 132, E - 98, or 74% of 132 papers.

Conclusion

These are the findings from an investigation of a statistical sample of the Algebra 3 papers. If the paper is considered a fair test of the principles involved in the course, certainly these results indicate a very serious ignorance of the principles underlying the course and a decided weakness in mathematical manipulation. From such results, even from a most difficult paper, the same conclusion differing only in degree, must be drawn.

CHAPTER 1V

THE QUESTION PAPER

1. How adequately does the paper cover the Course?

The course consists of nine topics each developed by a chapter. Eight of these topics are tested in a more or less degree in Section A of the paper, and the ninth appears as one of the options of Section B. The marks given to each topic, out of a total of 120, are indicated:

1.	Ratio and Proportion--Variation	10
2.	Functions of One Variable	4
3.	Limits and Gradients	6
4.	Differentiation	40
5.	Integration	15
6.	Sequence and Series	17
7.	Permutations and Combinations	15
8.	Binomial Theorem	3
9.	Empirical Formula	10

Although the total mark assigned to Differentiation seems unduly large, it must be borne in mind that this topic is almost the culmination of the two preceding chapter. Fifty marks for these three chapters is not excessive. Possibly three marks are too few for the chapter on the Binomial Theorem. Otherwise one cannot but agree with the opinion of the Chairman of the Algebra 3 Marking Group who in his report states, "The paper appears well distributed over the year's work".

2. Is the examination paper a fair test of the Course?

To decide this, an appraisal of each question will be made.

Question 1 (a) & (b).

The term "continued proportion" is defined in one line in the text, and no questions using the term appear at all. The solutions depend on a working knowledge of surds, and thus are a review of Algebra 2 & Geometry 2.

Question 1 (c).

The principles underlying this question are certainly covered by the text, although the question itself is equal in difficulty to any that appear. Root variation is not met with very frequently in the text.

Question 2 (a).

This question is confusing. Certainly many who understood the symbol "f(a)" misinterpreted the question. It was probably undervalued, a similar question on the 1936 paper received eight marks. The effect of a possible undervaluing of a question would be an increase in the time required. This effect is referred to later.

Question 2 (b).

Again, this question was probably undervalued. A similar question in 1935 received eight marks. On the 1937 paper two marks were given for sketching $y = \frac{1}{x^2}$

Questions 2 (c), (d), (e).

Question 2 (c) was misunderstood. This is shown by the fact that 53% of the candidates gave a correct solution in both 2 (d) and (e) where only 23% were successful in 2 (c).

Question 2 (f).

The graph of such a function very likely could not have been dealt with in the course. Such a function is dealt with in the summary at the end of a section, but the graphing is not directly mentioned for it or any similar function.

Question 2. -- Summary

"Some of them (the questions), e.g. 2, require a little more insight into the principles involved in the course than sometimes is the case on examinations. We agree that some work of this nature should find a place on the examination." (Examiner's Report)

This may well be true, but undoubtedly this question as a whole was found very confusing. The questions are tricky, and being undervalued, took too great a proportion of the student's time. A better arrangement of the paper would have placed this question, a short answer type, at the end.

Question 3 (a).

This is certainly a fair question, as five similar ones appear in the text.

Question 3 (b).

The purpose of the question presumably was to test differentiation. Unfortunately the solution requires such a detailed knowledge of index laws that the question fails in its purpose. The teacher has difficulty enough in developing concepts in functionality, and the meaning of the process of differentiation without taking time to drill on the intricacies of the Index Laws.

Question 4.

The question is as difficult as most in this very difficult section of the text. It is the author's opinion that the Second Differential has not been stressed by the teachers as a test of the Turning Point. In fact, it is not definitely indicated as such in the text. Undoubtedly students would be confused had they never used the second differential as the test.

Question 5 (a).

The question depends too much on the Index Laws to be a good test of the subject, "Geometric Progression". This statement is borne out by the fact that 37% of the students attempting the question, having applied Geometric Progression formula correctly, failed to apply, or apply correctly, the necessary Index Laws to complete the solution. Thirty-three per cent did not attempt the question, making the question second in this respect. The influence of index laws on this factor is, of course, problematical.

Question 5 (b).

This is a good test of the Arithmetic Progression concept, although thirty-one percent of those attempting the question, (twenty-eight percent of the total) were confused by the "10" factor.

Question 6.

The subject of annuities is probably one of the most difficult in the course. However, this is one of the easier problems, and is solved as a type question in the text.

Question 7.

The question was certainly undervalued at three marks. A simpler question in 1935 was valued at eight marks.

Question 8.

As in Question 3 (b), on Differentiation, the correct solution is dependent to a large extent on a knowledge of index laws. Forty-eight per cent of those attempting the question had difficulty with indices.

Question 9.

This question, although it has no parallel in the text, is answered better than most on the paper.

Question 10.

This is probably one of the most difficult questions in the chapter on Differentiation. In the similar questions in the text the relationship between the sections is stressed, whereas on the paper, each step is treated as an entity in itself. Arranged in this form to aid the student, the effect was to cause the student to overlook the relationship, as in

Question 10 cont'd

too many cases parts (c) & (d) were attempted when parts (a) & (b) were left untried.

Question 11.

The question is as difficult as any in the chapter on Integration.

Question 12.

This is certainly a fair question, undoubtedly overvalued.

Question 13.

Again, this question is as difficult as any in the chapter.

Question 14.

This question has no counterpart in the text with the exception of one question in the Revision Exercises, where an "x" factor appears in the denominator. This can hardly be considered a fair question.

3. Was the paper unduly long?

Certain factors would indicate that the paper was too long. The Table on page 33 shows that an average of eighty-five percent of the question paper in terms of marks was attempted. No definite conclusion can be made from such a figure except by comparison with figures similarly arrived at from other papers. A question was considered "attempted" if any manipulation of the given facts was made. The author feels

that a student "attempts" everything he has time for, and therefore concludes that eighty-five percent indicates a lack of time. Furthermore, many questions were valued at less marks than on previous papers, some very much so. This would indicate that the 1938 paper was longer than previous papers.

Conclusion:

All things considered the paper was certainly too difficult. Several questions undoubtedly are as difficult as any on its respective topic in the text, viz.: 1 (c), 2 (a), 4, 5 (a), 9, 10, 11, 13, with Question 14 more so. Such an examination cannot be considered satisfactory, especially in view of the fact that so much time must be used for concept development, and so little is left for drill on principles. Surely an examination can be prepared to test the principles of Algebra 3 without giving as the test of a topic as difficult a problem as the student has ever experienced. It is also felt that, in an examination on a course developed as this is developed, more options should be allowed. Certain factors indicate that the paper was too long. For these reasons it is felt that the paper was too difficult.

Chapter V

THE ALGEBRA 3 COURSE

The Grade XII Algebra Course, as outlined by the text covers nine mathematical topics. To the traditional topics of High School Algebra,--Variation, Proportion, Series, Binomial Theorem, etc.,--has been added an introduction to the Differential Calculus and the Integral Calculus. The result has been to make this course one of the most difficult on the High School Curriculum, difficult enough to be considered University Mathematics.

The methods used in the development of these topics or units are essentially sound psychologically, and are in conformity with recent trends in the teaching of mathematics.

Underlying the whole course is the concept of functionality,--the relationship existing between two or more variables. Klein calls this "the very soul of mathematics".[1]

Relationships existing between the different topics is indicated wherever possible, showing the unity in subject matter and method in mathematics. Furthermore, the indicated relationships between the different topics provide the best kind of drill,--a reunderstanding of a concept.

The text-book follows an inductive or generalization method as opposed to the drill method used so extensively in older texts. In such texts a bit of theory might develop a generalization, a type question would show the use of that

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[1]The National Council of Mathematics--Seventh Year Book Page 57

generalization, and this would be followed by an exercise of ten or more problems to be solved in much the same manner as the "type". The purpose was to teach the use of a generalization. The more modern texts are based on the principle that the development of the generalization is of equal importance to, if not of greater importance than the use of that generalization. In such texts material is presented from which inductions are made in the form of mathematical law or a generalization of method. In experiencing a variety of situations or conditions from which a generalization is to be drawn, the students' concept of a mathematical symbol or law gradually expands; the meaning attached to a term increases.

There can be no question as to the relative merit of the two methods. Admitted that the solution of most of the deductions in the drill exercise requires hard thinking, yet practice in generalization from a series of situations or experiences has more value for subsequent experience than drill on any one type of problem. On this question Jablonower says:

"While for the purpose of circumventing examination boards we may classify the types of verbal problems to which the Boards are compelled to limit themselves, and drill our pupils on the basis of such classifications, we are not giving the children much gain in power to meet novel situations, for in the process of drilling we have taken out the element of novelty which is the essence of the problem." ..."We ought

instead to be devoting our whole energy to arousing interest, stimulating curiosity, compelling hard thought".[1]

These then, are the modern trends in Mathematics:--the development of the concept of functionality; training in generalization from a series of situations or experiences; and the substitution for the old drill by repetition, drill through reunderstanding. The methods used in "A New Canadian Algebra" are essentially these methods.

An examination testing a course based on the "drill" method is not difficult to prepare, and there is no question as to what it should contain. A series of questions are given based on the mathematical principles, the use of which the student has been practising all year on very similar questions. Almost without exception, satisfactory results have been obtained. Thus with the present Trigonometry course, no examination in its history has produced the debacle we find in the Algebra 3 papers of last year. It might well be that a different form of examination is needed for the Algebra course, in which the students spend so much time discovering mathematical principles and so little time in drill on those principles.

The 1938 paper was divided into two sections, Part A, and Part B. Part A was composed of nine questions which tested eight of the nine general topics in the text. Part B was composed of more difficult questions, and was presumably in-

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[1]The National Council of Teachers of Mathematics--Seventh Year Book Page 13.

tended to give the better students something wherewith to show their mettle. It is conceivable that the single question testing the topic is not a fair test of the course. Probably a better "set-up" would be an examination such as: "Here are fifteen (or twenty) questions. Any six questions constitutes a full paper". Also to ensure that more than one topic is dealt with by the student, the twenty questions could be arranged in groups and a restriction placed on the number of questions to be attempted from each. These are only suggestions, of course, but the form is used to advantage in History papers and was used in previous papers in Algebra 3, Bearing in mind the development of the Algebra 3 course, the suggested examination form might be a much fairer test.

In the older mathematics texts, of which Conant's Trigonometry is an example, the mathematical principles and laws which formed the course were very definitely marked out. Thus there was no difficulty in knowing what to drill on for examinations. The Algebra text presents an entirely different situation. There is no definite limit to what the course contains. In many questions a principle is implied, the teacher may draw attention to it, and presumably the students understand its significance. Unfortunately in too many cases the principle is met with only once, and teacher and student alike assume that the point, though interesting, is merely a side issue in the general subject under discussion. The result is that the course becomes a voyage of discovery with a

great many detours on the way, all of course having some connection with the general route. The number of possible digressions are numerous, and will be determined by the background of the teacher, by the relative importance he attaches to the main topic and digression, and by the time at his disposal. With such an arrangement of the course there can be no quarrel. The difficulty arises when the students are called upon to face an external examination. When there is no definite limit as to what the course contains, it is conceivable that the single question per topic is an unfair examination.

Chapter VI

OTHER POSSIBLE CAUSES OF THE POOR RESULTS.

Two other factors in addition to the form of the examination may have been instrumental in producing the poor showing. The mathematical background of the students may be such that they cannot absorb the Grade XII course in one year. Also, past examinations and their results may have had a big influence.

In the author's opinion students have entered Grade XII without sufficient background for the Algebra 3 course. Their two years of Algebra consisted primarily in a study of the number system, factoring, simultaneous solutions of linear and quadratic equations, indices, and surds. For the most part it was a drill on the so-called fundamentals. The amount of graphical work was meagre, and too often taught as a separate entity, probably during the last two weeks so the student "wouldn't forget". The word "function" probably never would have been heard of, and the idea of an expression varying as "x" changes in value, never experienced. Consider this as the background for the Grade XII Algebra. This is the group to whom must be presented in six months the Differential and Integral Calculus, which are so dependent on a highly developed concept of functionality. Furthermore, into the Algebra 3 class has come everyone lucky enough to pass the Junior Matriculation Mathematics. These come into what is

considered a University Mathematics Course. To the credit of the Department of Education, this much must be said, that both difficulties are now partially overcome. A new text-book on elementary Algebra has shifted the emphasis, and will probably give a better preparation for the work in Grade XII. Also the teachers are given a voice in deciding who shall take the Grade XII Mathematics. The criticism is valid, however, for past groups and the present group.

Past examinations, both in their form and in their results, had an effect on the 1938 answer papers. Although teachers cannot be accused of teaching only for examinations, past examinations do determine where the emphasis on a course will be placed. This is especially true during the review period, and more so with relatively new subjects such as the course under discussion. Much of the 1938 paper had never appeared before. Most of Question 2 appears on a Final Paper for the first time. The Annuity Question has previously been optional. Question 10, probably one of the most difficult bits in the Chapter on Differentiation appears for the first time. The Maxima and Minima Question #4 has been optional. The same is true of the question on Volume and the Emperical Formula of Logarithmic Form. Both these questions are the most difficult in their respective chapters. Question 11 introduces a new situation. The teachers were looking for a paper based on the easier sections of the text,--a paper similar to previous papers. Very likely the students were

unprepared for the examination due to what might be considered poor judgment on the part of the teachers. On the other hand the teachers may have been justified in expecting an easier paper. With the Algebra course developed as it is, it is certainly not to be expected that our students will be masters in application of principles to questions as difficult as they experience in the text.

Whether it should or not the final examination does set the standard. Had the teachers known that on the 1937 paper forty percent made less than fifty marks there might have been a personal stocktaking. Had a higher standard been demanded the year that the course was introduced the poor results of the past two years might not have been experienced.

SUMMARY

1. The form of the paper,--one question per topic,--may be an unfair examination for this type of course.
2. The student's background may be such that the proper teaching of Algebra 3 is an impossibility.
3. Past examinations have not encouraged a high standard.
4. The paper itself was too difficult for the course.
5. The result was the very poor showing made by the candidates, as indicated in the report on the investigation of the answer papers.

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